The Importance of Agroforestry Systems for Mitigation of Climate Change in Tropical Africa

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Abstract
The most important agroforestry systems (AFS) in the region of tropics are spread woody plant diverse crops, farmhouse woody species planting, and multistory dwelling and also described the traditional AFS as Coffee Shade, home-gardens, woodlots, farm border plantation, and woody plants on grazing lands .those system highest potential to environmental management a humans have always demand from nature for environmental assets. This review shows that the traits of climate change mitigating the capacity of AFS in tropical Africa. The AFS has a vital role to reduce the external change of CO_2 and mitigation through GHG sink from the atmosphere. According to several land-use carbon sequestration reports, the AFS has been known as having the best possible for carbon-capturing from the atmosphere compared to the whole other land uses. This land use has a significant quantity of carbon stored in the total biomass pool compared to mono-crops and or pasture. The aboveground biomass carbon in AFS is estimated to be 2.11 × 1091 Mg C yr^{-1} in the region of tropical Afric. The multi-strata AFS has the highest(16-36 Mgt ha-^{1} yr^{-1}) carbon sequestration were reported, estimated that soil organic carbon (SOC) was highest Fruit-coffee agroforestry systems for 186.41 Mg ha^{-1}, followed by 178.8 Mg ha^{-1} in the coffee-enset, and 177.8 Mg ha^{-1} in the Enset system at 0-60 cm depth in Tropical Africa. According to IPCC and several research results, nowaday AFS as part climate change mitigation strategy. Generally, conserving trees on agriculture land and pasture lands highly recommended as enhancing mitigation capacity of AFS in tropics.
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1. Introduction

Climate change is a worldwide problem, it has a known challenge of species biodiversity and natural ecosystems in the global. According to IPCC (2013) report, the expectation of temperatures is rise range 1.10–6.40^{0}C at the end of the twenty-first century relative to 1980–1999. The tropical Africa region is the highest exposure to climate change vulnerability in the world. Overall, the temperatures of the region have been risen by 0.7°C throughout the 20s century. The Africa temperature rise is predicted with a range of 0.2°C per decade to more than 0.5° by low scenario and high scenario, respectively (Hulme *et al*. 2001; IPCC, 2001, while the Precipitation patterns of tropical Africa region is sensitive to variability.

the tropical region of Africa climate change is also associated to alter in the occurrence and magnitude of excessive actions such as the incident of El Niño–Southern Oscillation (ENSO), that is, El Niño and La Niña (Korcha and Sorteberg 2013; Midgley and Bond, 2015). Climate variability and extreme events impacted on Ecosystems in Ethiopian.

The Ethiopia precipitation patterns are contributed to agriculture production especially crop, loss of livestock, natural resource degradation and even famines in the past. According to the National Meteorological Agency (NMA, 2006), Ethiopia has known 10 wet years and 11 dry years over the last 55 years, demonstrating strong inter-annual variability. Besides the range between 1951 to 2006 the yearly minimum temperature in the country rise by about 0.370°C every 6 decades that is 0.3 ^{0}c high lands and 0.4 ^{0}c low lands. However, the outcome of the IPCC mid-range release scenario shows that compared to the 1961-1990 average, the average yearly temperature throughout the country will rise by ranging 0.9 to 1.1^{0}c in the year the 2030s and with ranging 1.7 to 2.1 9 ^{0}c in the year 2050s.

Afforestation and reafforestation activities have the potential to up to 25% reduction of atmospheric CO_2 by carbon capturing and also assisted in adaptations and sustainable development (Reyer *et al.,* 2009). Agroforestry systems have capable to reduce the outward flux of CO_2 and mitigation studies were identified as the capacity of AFS to have long term GHG capturing (Verchot *et al.* 2006). Based on IPCC (2001), Agroforestry has been known as having the most possible for the total carbon sequestration rate of comparative fro the whole land uses evaluated. The integration of woody plants on farmland or pastures can raise the quantity of carbon sequestered, which has a substantial amount of carbon stored in aboveground biomass and belowground with relative to a single crop plant or pasture (Sharrow and Ismail 2004; Kirby and Potvin 2007).

For these reasons, AFS has often more productive, taking up a large quantity of CO_2 from the atmosphere and storing the carbon in live vegetation biomass, organic matter of soil, and harvested wood products (Schoeneberger, 2009; Seta and Demissew, 2014). Agroforestry would tender the highest capacity of the carbon sink in less economically growing nations (Smith *et al*. 2007; Verchot *et al*. 2007). Now day AFS is expected to be experienced on 1000–1023 MgCha-[1] worldwide and to sequester from 30.0 to 322 C Pg yr (Zomer *et al.* 2009; Jose and Bardhan 2012). This review paper aimed to assess the AFS capacity of environmental services and mitigation reduction capacity in tropical Africa and Ethiopia.

Most time land-use competition, land tenure forest resources, continuous population growth, and rudimentary farming techniques are significantly affected forest resources in Ethiopia (Bishaw, 2001; Richard, 2006; Hailu and Asfaw, 2011). To maintain those problems, established agroforestry can aid to decrease demands on remains of natural forests from deforestation and to enhance soil fertility (Kang and Akinnifesib, 2000; Gustavo, 2004).

2. Discussion

2.1 Concept of Agroforestry

The Concept of Agroforestry is a land-use system that integrates trees (woody perennials), crops, people, and/or animals on the same piece of land to get higher productivity, greater economic returns, and more social benefits on a sustained basis (Kang, 1992; Oyebade, 2010). According to Nair (1993), AFs generally were categorized into three mainly as agrisilvicultural, silvopastoral and agrosilvopastoral. The most wildly usual agroforestry practices (AFP) in region of tropical Africa are spread woody vegetation on crop fields, homestead woody planting and multi-strata home garden (Nair, 1993; Nair,1984; Young,1989), the agrisilvicultural with spatial diverse arrangement in Ethiopia, the explained AFP of which is largely implemented for soil richness replenishing purpose for degraded soil. Ashagre, (1997) and Bekele, (2007) also described the common AFP in various parts of the region as coffee shade based sprinkled woody plant on the cropland, homestead, pieces of a land plantation, border of plantation practices, and woody plant on pasture lands.

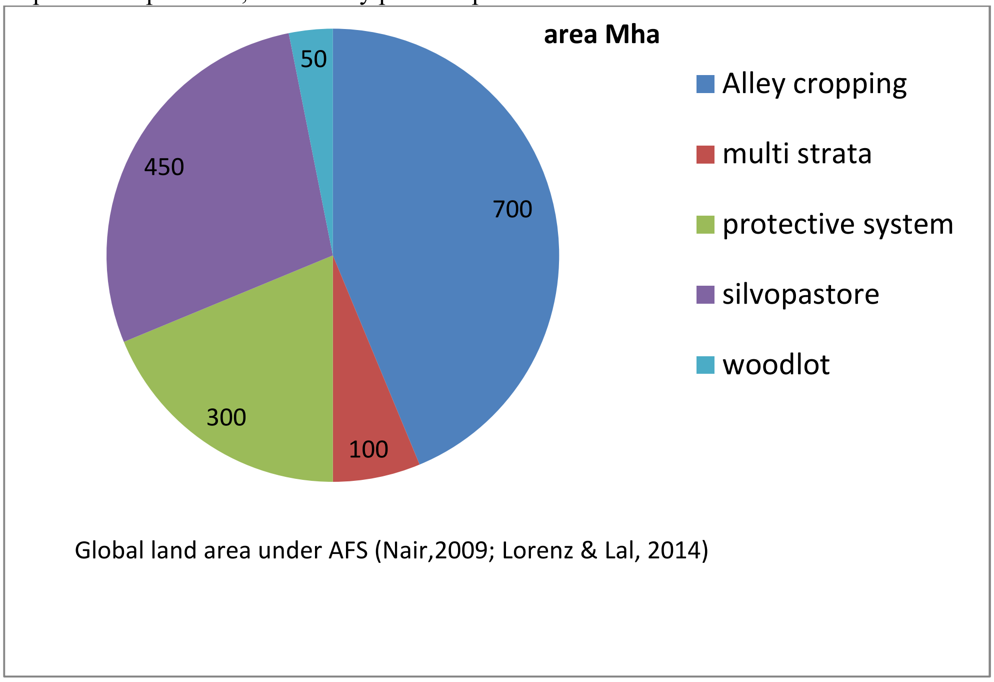

Figure 1: Same AFS Global land cover are presented

2.2. Major Agroforestry Practices in Tropical Africa

The agroforestry concept in tropical Africa is not new. This is very old practices whereby in the smallholder farmers maintain various woody plants on croplands. The major tropical agroforestry practices are Alley cropping (hedgerow intercropping), homestead, boundary planting, Improved fallow fast-growing, versatile woody plants on farms land and grazing land, Silvopasture, Grazing systems, Cut and carry system (protein banks), Shaded perennial–crop systems, Shelterbelts and windbreaks, and Taungya (Nair, *et al.,* 2009).

The parkland and home gardens are the well-accepted AFS in most parts of the tropical region especially Africa (ex. Ethiopia, Kenya...). It was reported by (Agize *et al.,* 2013). Additionally, nine types of Profitable AFPs for ecological and socio-economic services were identified in various parts of Ethiopia. These are banana-based multi-story gardens, teff, and acacia system integrated, boundary eucalyptus and cereal crops, conservation-based vertically and horizontally packed agroforestry, multi-strata perennial crop, enset-coffee-tree-spice-based, fruit trees-bamboo combined with enset-vegetable farming and bamboo combined with cereal farming agroforestry (Bekele, *et al.*, 2007).

The main Cash crop AFS are coffee, khat, and fruit-based systems in the country. According to FAO (2009), the coffee-based system is occupying over 9.80 million ha of land worldwide. Ethiopia has four coffee production systems of AFS such as forest coffee, semi forest coffee, garden coffee, and plantation coffee (Woldetsadik and Kebede, 2000).

Table 1: area coverage and production of the three cash crops Fruit, coffee and khat, 2010/ 11 in Ethiopia

cash crops	No. farmers	Area of cultivation		production	
		Area (ha)	Sharing (%)	ton	Share (%)
Fruit	2658415	51,078	9	403459	45.6
Khat	2068262	214112.19	37	244641.96	27.1
Coffee	3049120	313608.98	54	253038.38	28.3
Total	7775797	578799.17	100	901139.34	100

Source: Woldu, *et al*., 2015

2.3. .Agroforestry for ecosystem services

Ecosystem services were defined in the different aspects, including "the benefits human populations derive, directly or indirectly, from ecosystem functions" (Costanza *et al.,* 1997). According to the millennium ecosystem assessment (MA, 2005) a worldwide program set up in 1999 to evaluate how ecosystem change would affect human well-being. The communities are benefited from the ecosystem in the form of supporting services, provisioning services, regulating services and cultural services. The benefits community gain from ecosystems through religious enrichment, cognitive development, education, recreation, and aesthetic experiences.

Agroforestry systems can be contributed to environment function: Humans have always depended on the natural world for ecological assets like freshwater, nutrient cycling, and soil formation. Simultaneously reducing greenhouse gas concentration by sequestration of CO_2 (Kongsager *et al.* 2012). The systems have been understood as one of the incorporated forest and soil resource management interventions for addressing a variety of ecological and community challenges. The integration of woody plants, cash crops, and field crops and/or animals into an AFS has the likelihood to improve soil productiveness, decrease soil erosion, improve water quality, enrich biodiversity, increase aesthetics and sequester carbon.

According to Sileshi *et al.,* (2007), agroforestry practices in southern and east Africa revised results were provided three categorical services. A. *Provisioning services* such as genetic resources, food, basis of power and feed, e.g. Over 80% of the rural society in southern Africa also depends on therapeutic plants for most of their health needs. B. *regulatory services* including microclimate change, erosion control, alleviation of desertification, carbon sequestration and pest control, and C. *supporting services* namely, soil fertility enhancement, biodiversity maintenance and pollination in the miombo eco-region.

Agroforestry has a great role to mitigate climate change and different sources of income in developing countries, especially during the mechanisms for accounting and compensating for carbon sequestered in agroforestry become widely available to the small-scale farmers (Nair, 2010, Negash, 2013).

Table 2: Agroforestry practices benefit in the special and temporal scales

Ecosystem Services	Special Scale		
	Farmer/ Local Level	Landscape/Regional Level	In the world
Production of Net Primarily			
Control of Pest			
Pollination/Seed Dispersal			
Soil Improvement			
Soil Stabilization/ Control of Erosion			
Clean Water And Air			
Flood Mitigation			
Carbon Sequestration			
Biodiversity			
Aesthetics/Cultural			

Source: Jose, 2009

3. Agroforestry and climate change mitigation

The subsistence agriculture land is highly susceptible to climate change in Tropics, as individual farmers do not have sufficient wealth to climate change an adaptation, While AF has a great play of substantial function in mitigating of climate change through reduction of GHG from the atmospheric, this is also contributing to play in helping individual farmers adaptation of climate change (Louis, 2007; Eike *et al*., 2014).

Agroforestry practices are more diverse than single crop farmlands. Thos are practicing annual and perennial plants and also included with livestock. The climate elements (temperature, relative humidity, and ambient CO_2)

concentration affect all organisms involved in an AFS, possibly in very different ways, and climate change is projected to alter all of these factors. Climate change mitigation, woody plant-based farming systems are at present being encouraged in many parts of developing regions including tropical Africa (Garrity *et al*., 2010). Trees management based agroforestry systems have a substantial play in the reduction of GHG concentration from the atmosphere.

3.1. Carbon Sequestration rate capacity of Agro-forestry systems

The sequestration rate of carbon is the subtraction of additional carbon from the atmosphere and depositing it in another reservoir principally through the change in land use (IPCC, 2000, Mandal *et.al,* 2005). And also state that sequestration rate of carbon as the progression of taking away carbon from the ambiance and then put into storage in plant. It entails the relocate of atmospheric CO_2, and its locked stock in long time storages. From the plant growth of view, it initial processes the uptake of the source of CO_2 throughout photosynthesis and also shifts of the permanent carbon accumulation into aboveground biomass, and soil carbon pools for protected (i.e. long-term) stock. Different studies are encouraging widely implemented AFS as a strategy of carbon sequestration rate that is focused on carbon-rich multistory AFS in the moist tropical forest limitations (Palm *et al.,* 2004). Though drylands tropics have a shortage of information on the capacity of carbon sequestration (Negra and Ashton 2009), and also in meticulous about AFS carbon sequestration rate in sub-Saharan Africa (Takimoto *et al*. 2008) and Eastern Zambia (Kaonga and Bayliss-Smith, 2009).

Agroforestry system offer opportunities for the creation mitigating of climate change, and have a practical mitigating possible of representing a sequestration carbon rate of carbon capacity of 391,000 $MgCyr^{-1}$ by 2010 and 586,000.0 MgC yr^{-1} 630 million ha of infertile croplands and grasslands could be transformed to AFS by 2040 in the tropics (Jose, 2009). Estimation of the capacity of sequestration rate of carbon from aboveground biomass to be 2.1×10^9 $MgCyr^{-1}$ from AFS in tropics (Oelbermann, *et al.,* 2004), as well as agroforestry systems, were practiced by individual farmers have potential to C sequestration rate ranged from 1.50 to 3.50 $MgCha^{-1}yr^{-1}$ in the tropics (Montagnini and Nair, 2004). However, the net carbon balance in all carbon pools varies based on the kind of AFS, with reported C changing from a range of 0.31 up to 7.71 MgCha $_{-}^{1}$ y_{-}^{1} in biomass and 1.01 up to 7.40 $MgCha_{-}^{1}y_{-}^{1}$ in soil (Kim, *et al.,* 2016). It has indirect that effect of systems structure, composition, and management on carbon-capturing ability in each component.

Agroforestry systems are alternative of resource to reducing natural forests overutilization and also it is one of the largest sinks of terrestrial carbon, enhance carbon storage in woody (tree) and soil pools. However, estimating the carbon sink capacity of AFS in the drylands is important for carbon secretarial purposes. Due to low vegetation growing and cover, naturally, poor soil C levels and then these areas have poor carbon storage performance (Lal, 2003). However, these dryland areas transformed into agroforestry land use seem to possess a massive capacity to capture carbon from the ambiance. Moreover, the scope to which woody plans uncultivated land-use systems like as woodlots as rotational practices, decreasing illegal cutting pressure of the conserved natural grower forests in semiarid regions and thereby counterbalance CO_2 emissions has been minimally investigated.

3.1.1. Biomass Carbon Stock Potential of Agroforestry Systems

According to the Kyoto protocol, AF was accepted as a C sequestration action under the afforestation and reforestation (A & R) actions and it is paying attention to special attention as a C sequestration policy. This recognition was reason out the growing structure that accumulating the highest volume of aboveground biomass (AGB) and root development process of the woody plant in the AFS. So far, several types of research outputs were indicated AFS under different ecological regions have C sequestration potential become obtainable since the mid-1990s starting. Most of these available reports on carbon sequestration rates and stocks were presented (table 4). In AFS are estimates of carbon stocks in above ground biomass- and belowground(root biomass plus soil) compartments, quantified amount of carbon is, or potentially could be, capturing and preserves AFS under different ecological situations and management. The estimates ranging from 0.29 up to 15.210 $MgCha^{-1}$ $year^{-1}$(Nair *et al.* 2010). The Cocoa-based agroforestry systems are recognized for storing a substantial quantity of carbon in the systems. For this reason, it has possible to mitigate climate change. Besides, shaded agroforestry systems with perennial crops like coffee (Coffea arabica L.), rubber (Hevea brasiliensis) (Muell.-Arg.) could help to mitigate climate change and cocoa-may vary between 12 and 228 $MgCha^{-1}$ (Nair *et al*., 2009). Similarly, Negash & Starra (2015) fruit-coffee, coffee-Enset and Enset systems of carbons stock vary within 22 and 122 Mg ha^{-1} in Refit valley Ethiopia.

Major Agroforestry systems of biomass carbon stock in the tropical regions have in a locked large quantity of carbon, and their reduction capacity of CO_2 through improved by changing appropriate woody plant and annual crop species in presented AFS (Verma *et al.,* 2009).

Table 3: Mean Biomass carbon stock potential Agroforestry systems in some tropical regions.

AF System	Sub systems	Location	Mg C ha -1	citation
Multi strata	Inga-coffee, pines-coffee, coffee	Humid tropics	60.6,124 &107	Lenka *et al.*, 2015
Multi strata	Home garden	tropics	101-126	Saha *et al*. 2009
Silvopasture	Browsing system	Sami tropics	6.55 yr	Shreshtha & Alavalupati, 2004
Woodlot	Fodder (acacia. Spp.)	tropics	180	Kumar *et al*. 1998
Parkland	*Faidherbia albida*	West African Sahel	54	Takimoto, 2007
Parkland	*Vitellaria paradoxa*	West African Sahel	22.4	Takimoto, 2008
Live fence	*Acacia nilotica*	West African Sahel	8.3	Takimoto, 2008
Fodder bank	*Gliricidia sepium*	West African Sahel	4.1	Takimoto, 2008

Source: (Nair *et al*., 2009)

Many factors are affecting biomass carbon accumulation, including the species growing nature, land suitability, age, application and type of managing carry out and their interface within the woody plant and cash crops of the understory in an AFS (Jana *et al.* 2009; Kanime *et al*. 2013). The total (above + below ground) biomass carbon stock in the specific country was indicated in table 5. The highest of 239 MgCha $^{-1}$ from the woodlot, followed by 123 MgC ha $^{-1}$ in Alley cropping and 77 MgCha $^{-1}$ in the multi strata systems total biomass carbon stocks were reported by Bajigo *et al.* 2015, Makumba, 2006 and Negash & Starra, 2015 in Ethiopia, Malawi, and Ethiopia, respectively.

Table 4: Mean biomass (above +below) carbon stock in humid tropics and tropical Africa countries including Ethiopia

AF System	Subsystems	Country	Mg C ha $^{-1}$	Citation
Woodlots	*L. leucocephala species.*	Zambia	24.5 - 55.9 &74	Kaonga, 2005
Woodlots	*Fodder bank*	Mali (ST)	0.29 yr	Kumar *et al.* 1998
Woodlots	*Live fence*	Mail (T)	24	Kumar *et al.* 1998
Multi-strata	*Shade coffee system*	Togo	6.31/yr	Dossa *et al.* 2008
Multi-strata	*L. leucocephala + maize*	Nigeria (HLT)	13.6/yr	Lal, 2005
Alley cropping	*Gliricidia sepium +maize*	Malawi(H&s hT)	123-149	Makumba, 2006
Woodlot	*Different acacia spp.*	Ethiopia	239.43	Bajo *et al.* 2015
Multi-strata	*Fruit-coffee, Enset -coffee & Enset*	Ethiopia	77.4, 77.5 &46.	Negash & Starra, 2015
Multi-strata	*Home garden*	Ethiopia	24.83	Bajigo *et al.* 2015
Multi-strata	*Sami forest coffee*	Ethiopia	61.5	Denu *et al.* 2016

3.1.2. Agroforestry systems and Soil Organic Carbon Stock

The soil is one of a large amount of carbon storage pool, it contains about 2,500 pg and it is four times a biotic pool (560 pg) and also it has three times higher than the full of atmospheric carbon concentration (760 pg) (Lal, 2004). The soil organic carbon content 58- 81% was taken up to 50cm depth. The recent studies reported a global SOC across all estimates of mean value 1460.50 Pg carbon, ranging within 504 to 3000 Pg C (Scharlemann, *et.al.,* 2014). The soil C stock agroforestry varies based on systems 124.29, 160.42 and 84.69 Mg ha^{-1} on mixed multistory, taungay, and falcata-coffee multistory AFS respectively (Labata *et al.,* 2012). The different scholars, AFs Soil organic carbon stock reports were showed table 6. The soil organic carbon (SOC) stock was highest Fruit-coffee agroforestry systems for 186.4 Mg ha^{-1}, followed by 178.8 t ha^{-1} in the coffee-enset, and 177.8 Mg ha^{-1} in the Enset system at 0-60 cm depth and the lowest amount of SOC stock was present 24 Mg ha $^{-1}$ in Live fence at 0-100 cm depth in Mali and land Agrisilviculture (*Gmelina arborea* +field crops) for 27 t ha -1 at 0-60 cm depth in central India.

The SOC amount varies based on the biomass input received from foliage, litterfall and on the recycling of fine roots (Rasse *et al.,* 2006). The relation to the plant's carbon in the soil system recycling also influenced by available of organisms (macro and micro faunal activity), on litterfall quantity and rate of decomposition (Hairriah *et al.,* 2001). And also, climate and vegetation cover are influencing the spatial circulation of soil organic carbon, concordance with similar studies in the European countries (Chiti *et al.,* 2012).

According to Garg Vk (1998), the carbon pool of soil depends on agroforestry practices that have been an increase by 2-3 Mg C/ha/yr. Moreover, carbon sequestration rates ranging from 16-36 Mgt ha-^{1} yr^{-1} were observed in the Tropical home gardens. The reports were shown, GHG mitigation potential of AF is 0.44- 1.89 MgCO_2-eq/ha/yr (Recha, *et al*., 2014).

Table 5: Mean Soil carbon stock in different soil depth in the different tropical countries

AF systems	Countries	Depth (cm)	Soil C Mg/ha	Reference
Agrisilviculture (Gmelina arborea +field crops	Central India	0-60	27.4	Swamy &prui 2005
Silvopastoral system	Costa Rica	0-40	132-173.5	Amezquita *et al.* 2005
Shade coffee	Togo	10	97.3	Dossa *et al*. 2008
Mixed story, toungay & Falcata- coffee AFS	Philips	30	124.3, 160.4 & 84.7	Labata *et al.* 2012
Home garden , Park land & woodlot	Ethiopia	0-30	61.57, 49.05 & 48.6	Bajigo *et al*. 2015
Fruit –coffee, Enset-coffe & Enset	Ethiopia	0-60	178.8, 177.8 & 186.4	Negash & Starra, 2015
Live fence (A*cacia* spp. &*Ziziphus mauritania*). & Fodder bank	Mali	100	24 & 33.4	Takimoto *et al*. 2008
Fodder plat +maize	Malawi	200	123-149	Makumba *et al*. 2007
Leucaena leucocephala woodlots	Zambia	100	140	Kaonga, 2005
Leuceana leucocephala woodlots	Nigeria	0-10	13	Lal, 2005

3.1.3. Tree species under agroforestry contribution to Carbon stock

Total ecosystem forest biomass and soil were shards more than 80% and 70 % of all terrestrial and all SOC carbon stores, respectively. In another way, the judicious land system and recommended agronomy practices also increase SOC stocks through another form of carbon pool (Binyam, 2014) and Brady and Weil, (2008) also trees can contribute substantially and more efficient in promoting to soil carbon sequestration. Manging trees that are integrated with grassland or pasture systems can be considerably increased carbon sequestration in the SOC content. According to several reports, the woody plant components of AFS are possible sinks from source carbon due to their fast growth and productivity, accumulation of high and long term biomass, and extensive root system. In another study, the agri-silviculture carbon sink was higher than 40% and 84% in mono-cropping of woody plants (tree) and provisions crops, respectively. It is representing that complex agroforestry practice has more capacity to carbon sequester rate from the atmosphere (Dhyani, 2009). Considering the individual woody plants on the soil organic carbon as beneficial effects, the different arguments were indicated that increasing biomass production (above and below) depends on tree density, which could substantially influence of SOC storage through litterfall and fine root decomposition. Hence the high amount of biomass produced that would help increased total biomass production including litter and fine root activities and then trees are incorporating with cash crops is a vital issue for carbon sequestration rate in soil (Lemma *et al.* 2007).

The most appropriate land management systems for mitigating atmospheric CO_2 through established agroforestry, afforestation and reforestation have been suggested as woody plant-based practices and or systems in the tropical AFS, (Albrecht and Kandji, 2003; Montagnini and Nair, 2004). The soil carbon sequestrations are significantly influenced by the litter biomass and fine root activities (Lemma *et al*., 2007). The quality litter biomass is higher sources of soil organic carbon stock and carbon sequestration rate through time.

The enormous quantity of root biomass carbon transfers from the root into the soil, so roots are a significant role in soil carbon balance. The below-ground biomass is a vital contribution to soil carbon sequestration through litterfall accumulation and decomposition rate, development of root, and turnover, root exudates (of organic substances). Additionally, it is influenced by rooting depth and then a substantial quantity of carbon is stored below the plow layer and better secluded from disturbance, which leads to longer dwelling times in the soil. Root carbon inputs can be substantial, although the amount declines sharply with soil depth, same reports were indicated that the rooting depths of some woody plants having greater than 60 m, (Akinnifesi, *et al*., 2004). During photosynthesis around 50.0% of the fixed carbon is transported belowground and partitioned among root growth, rhizosphere respiration, and assimilation to soil organic matter (Nguyen *et al.,* 2005; Strand *et al*., 2008).

4. Factors Affect Agroforestry Systems Carbon Stock

According to (example, Newaj & Dhyani, 2008) scholar report, the potential of agroforestry ecosystem carbon stocks are considerable varies across species and geographical location. Moreover, the quantity of C stock affected by the arrangement and purpose of various components of agroforestry within the systems put into practice. The other fact present reports have been argued AFS as a function of both the source and sink of carbon. There is also an obvious confirmation to suggest that the kind of AFS very much influences the source or sink role of the integration of woody plants. For example, agrisilvicultural systems where the woody plants incorporate in crop fields are net sinks while agro silvopastoral systems are possible sources of GHGs (Kandji, *et al.*, 2006). Besides, the unmanaged practices have significant emissions of GHGs which are Practices like the application of chemical fertilizers, manuring, frequent soil disturbances, tillage, and controlled burning. The other reports on intercropping of trees AFs reported an enhancement in SOC by greater than 50% due to leaf litter (Venkateswaralu, 2010). The tree density, age, structure, and composition were influences of AFS storage of carbon potential in different components (biomass and soil) (Swamy; Kaname *et al.* 2013).

The carbon of Soil may preserved centuries to accumulate under normal circumstances, but it has significant direct and indirect effects related to human-induced land-use cover on soil organic carbon stocks by changing the equilibrium between carbon sequestration and carbon losses, which are extremely difficult to restore in the short term. Numerous researchers have discussed possible soil carbon changes with land use and management practices (Li *et al.* 2010; Liu *et al.* 2013; Tesfaye *et al*. 2016).

Summery

Agroforestry systems are the integration of woody plants growing with crop and tree with livestock production. The integration of trees with other land use has the highest capacity for a sequestration rate of carbon than grazing and field crops. The woody plant (trees) is incorporated in the crop field and pasture lands were indicated a total biomass and soil carbon sequestration rate. The establishment of well-managed agroforestry systems has substantially the role of reducing the external change of CO_2 and similarly importance of the significantly long term to GHG sink and mitigation. According to different reports, the Agroforestry system has been predictable as having the largest capacity for sequestration rate carbon than all other lands. The integration of woody plants on cropland or pasture areas can enlarge the quantity of carbon sequestered related to single crop field or grassland. Although some estimates of the so-called “C-sequestration potential” of AFS are obtainable, these are mostly predicting of storage of net carbon. According to different research reports, the estimation of biomass and soil carbon sequestrations as methodological difficulties under AFS are several confines in exploiting this cheapest environmental advantages of agroforestry. Now a day the financing or trading of carbon is quickly increasing in the world. So far, the Kyoto Protocol clean development mechanisms propose a smart economic opportunity for subsistence farmers the major practitioners of agroforestry in developing countries.

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